Evaluation of indicator *E. coli*, fecal coliforms, *E. coli* O157 and *Salmonella* spp. in surface waters of the Southwest Regional canal network

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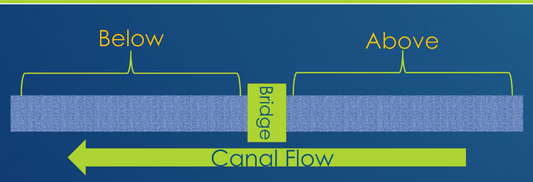
Introduction:

Irrigation canals are an important water delivery system for the Southwest desert farming region. Industry guidance and proposed produce safety regulations have recommended that stakeholders use fecal indicator bacteria as a proxy for deleterious water quality. It is unclear whether larger volumes or targeted sampling would improve monitoring strategies for canal irrigation systems.

Methods:

- Seven sites were sampled monthly for ~ one year (2013-14)
- Overpasses and bridges were used as selection criteria
- Paired, 20 L composite samples were collected above/below bridges (1-30m)
- High volume ultrafiltration (20L) was use to concentrate samples
- Samples were analyzed for indicator *E. coli* and fecal coliforms, *Salmonella* and *E. coli* O157:H7.
- Environmental, meteorological and water quality parameters were collected at each site.
- 30 m fecal transects and bird counts were performed during each sampling event



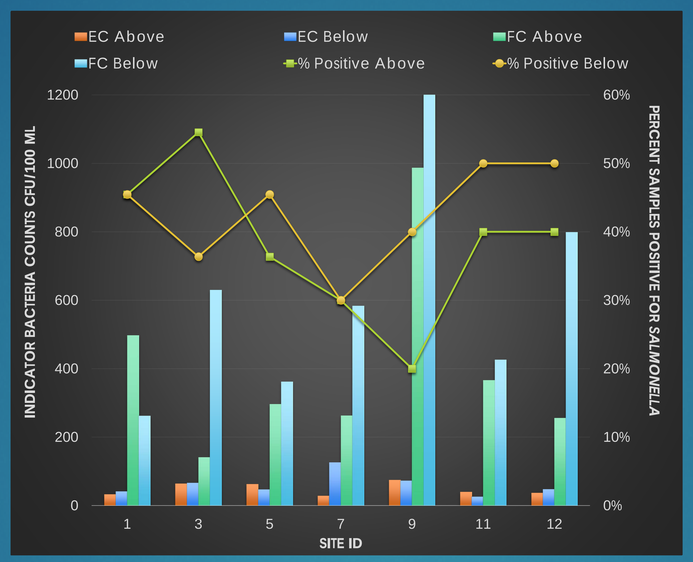


Fig 1. Graphical representation of microbial water quality results. Values represented by bars are arithmetic averages of bacterial counts for *E. coli* (EC) above (gold) and below (orange) a bridge, and fecal coliforms (FC) above (green) and below (blue) a bridge. Solid lines indicate the percentage of positive *Salmonella* results above (green) and below (yellow) a bridge for each site.

- **146 paired samples (n=73 pairs)**
- **Mean EC= 54.95, σ=87.79**
- **Mean FC= 501.76, σ=1,222.42**
- ***Salmonella* occurrence 40.41%**
- ***E. coli* O157 occurrence 0.68%**
- **Non-O157 STEC occurrence 6.16%**

Results:

The presence of *Salmonella* was not associated statistically with an increase in indicator bacteria (log transformed *E. coli* and fecal coliforms) (P>0.05). Average indicator *E. coli* counts (CFU/100 ml) were well below the LGMA standard of 235 CFU/100 ml ($\mu = 54.95$, $\sigma = 87.79$) and did not differ significantly between pairs of samples ($P > 0.05$) Fecal coliforns were marginally significantly different between sample pairs (P=0.055), with samples below bridges typically higher in concentration than those above, though this varied by site.

E. coli O157 positive for Shiga toxin was found in only one sample during the duration of the project (0.68%). Non-O157 STEC was detected in 6.16% of samples (9/146) and only in samples downstream of bridges. Occurrence of both *Salmonella* and STEC appear to be seasonally driven, and are negatively associated with one another.

Table 1. Arithmetic mean concentrations for *E. coli* (EC) and fecal coliforms (FC) upstream of bridges (Above) and downstream of bridges (Below), with the average difference between pairs (A-B). Sample size indications are for pooled (above-below) samples.

Site ID	EC Above	EC Below	Mean EC A-B	FC Above	FC Below	Mean FC A-B
1 (n=22)	32.7	41.5	-8.7	497.9	262.2	235.7
3 (n=22)	64.6	66.9	-2.3	141.2	630.1	-488.9
5 (n=22)	63.0	47.5	15.5	296.4	362.5	-66.2
7 (n=20	28.6	126.2	-97.6	263.6	584.2	-320.6
9 (n=20)	74.9	73.1	1.8	987.3	1232.6	-245.3
11 (n=20)	40.2	25.9	14.3	367.0	426.5	-59.5
12 (n=20)	37.6	47.9	-10.3	256.0	799.3	-543.3
Mean (n=73)	**48.8**	**61.3**	**-12.5**	**401.3**	**613.9**	**-212.6**

Conclusions:

While monitoring of bacterial indicators in canal irrigation systems may be a cost effective measure for understanding base-line microbial water quality characteristics, it does not provide guidance for the human health implications of waters being used to irrigate ready-to-eat commodities. With the high prevalence of *Salmonella* in 20L composite samples, more research will be needed to determine environmental factors most likely to contribute to pathogen occurrence.

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